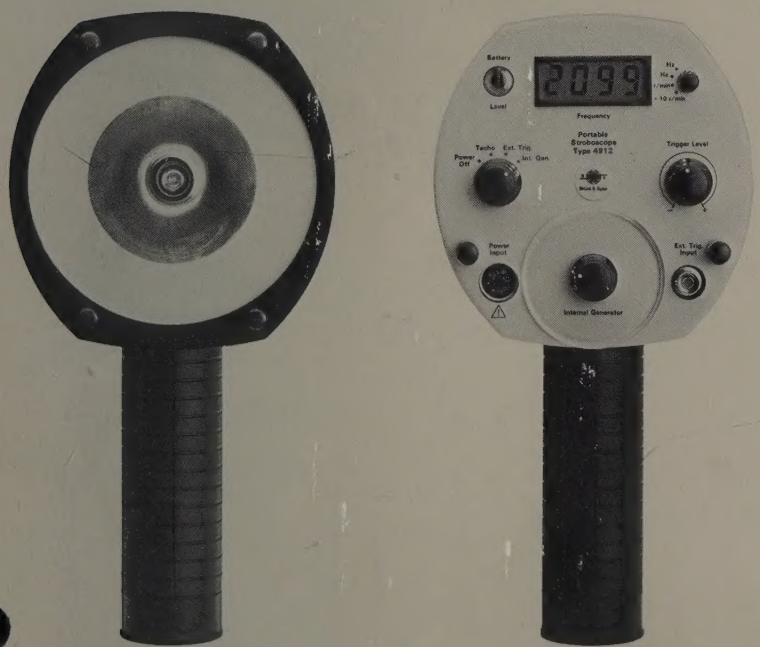
4912

Instruction Manual

Portable Stroboscope Type 4912



An ultra-compact unit combining a stroboscope with a tachometer. A 4-digit liquid crystal display indicates tacho frequency (from a choice of separately available transducers) or strobe-lamp repetition-rate in hertz or r/min. The flash rate may be synchronized externally or driven from an internal generator whose frequency range is 5 to 125 Hz (300 to 7500 r/min). Rechargeable batteries contained in the handle give typically 2 hours' operation from one charge. The xenon lamp provides a concentrated beam of white light whose brightness is independent of frequency above 25 Hz (1500 r/min).

Brüel & Kjær

PORTABLE STROBOSCOPE
TYPE 4912

From serial number 879442

Revision May 1985

SAFETY CONSIDERATIONS

The present Instruction Manual contains information and warnings which should be followed by the user to ensure safe and reliable operation and to retain the apparatus in safe condition. Special note should be made of the following:

SAFETY SYMBOLS

The apparatus is marked with this symbol where it is important that the user refer to the associated warning statements given in the Instruction Manual.

WARNINGS

Whenever it likely that the correct function or operating safety of the apparatus has been impaired, the apparatus must be made inoperative and be secured against unintended operation.

Any adjustment, maintenance and repair of the open apparatus under voltage must be avoided as far as possible and, if unavoidable, must be carried out only by trained service personnel.

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Portable Stroboscope

USES:

- Inspection of rotating or reciprocating machinery
- Mode study vibration testing
- Loudspeaker analysis
- Dynamic field balancing of rotating parts
- Speed/frequency measurement of rotary, linear or vibratory motions
- Investigation of high-speed repetitive industrial processes on the shop floor

FEATURES:

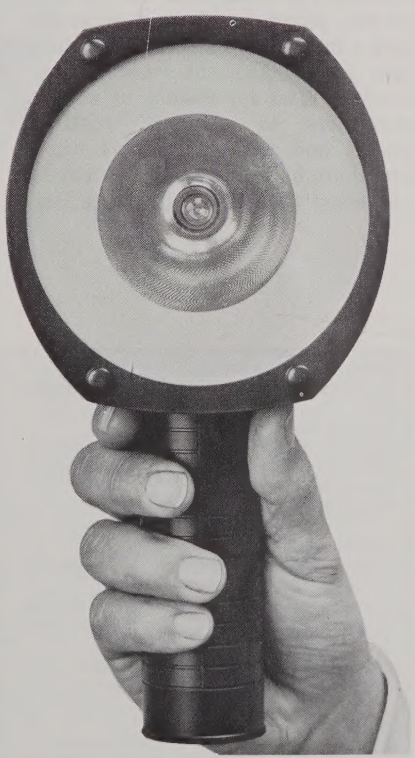
- Combined motion analyzer and tachometer
- Internal frequency generator range 5 to 125 Hz (300 to 7500 r/min)
- Flash rate obtainable 0 to 130 Hz (0 to 7800 r/min)
- Tachometer operation 0 to 1500 Hz
- External trigger range 0 to 20000 Hz
- Constant white light output independent of frequency above 25 flashes per second
- 4-digit liquid crystal display of frequency or r/min
- Compact self-contained unit for use in the hand
- Typically 2 hours' operation from built-in accelerated-charge rechargeable NiCd batteries
- External DC operation when required

The Type 4912 Portable Stroboscope is a compact hand-held instrument which combines the function of tachometer with that of motion analyzer. It permits both qualitative investigation and accurate measurement of various kinds of rapid, repetitive motion in trouble-shooting and design and development situations.

The Stroboscope utilizes the phenomenon of persistance of vision to "freeze" or slow down motion of vibrating, rotating or reciprocating parts of machinery too rapid for the unaided eye to perceive. When the machinery is illuminated by the flashing light from the xenon lamp in the Stroboscope and the flash rate is suitably adjusted, the illusion obtained is of stationary or slowly moving machinery. This illusion makes it very easy to assess qualitatively how the machinery is behaving, and it also permits comparative measurements to be made on the amount of motion taking place. Since the 4912 features a 4-digit liquid crystal display which can be set to either Hz or r/min, it can also be used to measure accurately the frequency of the motion.

The 4912 can be used as a tachometer or a combined tachometer/stroboscope, as well as a free-running stroboscope. In the free-running mode the lamp is triggered from an internal frequency-generator which may be adjusted between 5 and 125 Hz. The actual frequency is indicated on the display.

The 4912 can be triggered externally, via a coaxial cable, from a photoelectric tachometer probe MM 0012, (Fig.1) or MM 0024 (Fig.2), a magnet-



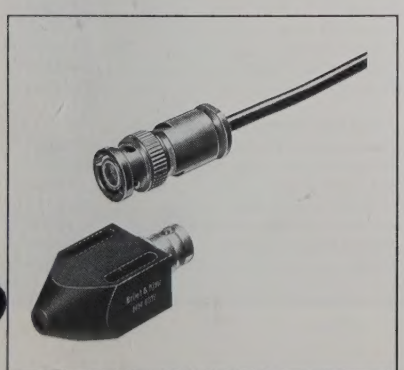


Fig. 1. Photoelectric Probe MM 0012

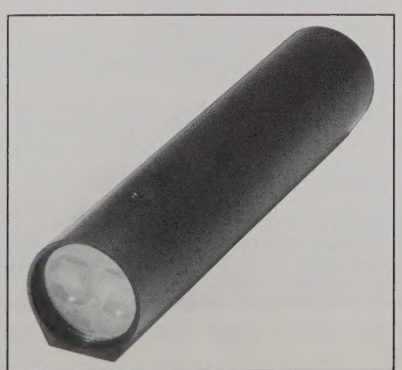


Fig. 2. Photoelectric Probe MM 0024

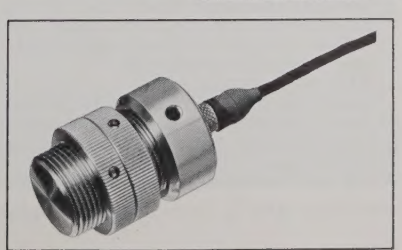


Fig. 3. Magnetic Transducer MM 0002

ic probe MM 0002, (Fig.3), a vibration meter (e.g. Type 2511), or a variety of other motion-sensing devices or instruments available from B & K. When it is used solely as a tachometer, the display will indicate frequency from 0 to 1500 Hz or the equivalent r/min. If the upper limit is exceeded, the display flashes to indicate out-of-range. When it is used as a stroboscope synchronized with the machinery or system being studied, the flash rate range is 0 to 130 Hz.

In this operating mode the external trigger will lock to triggering frequencies up to 20000 Hz, and if they are greater than 130 Hz the flash rate will be a submultiple of the triggering frequency.

The 4912 is a completely self-contained unit, powered from rechargeable batteries built into its carrying-handle. The integration of the light source, power supply and generator into a hand-held instrument weighing only 1,3 kg makes the Portable Stroboscope ideal for studies of moving machinery in cramped, confined spaces and remote locations where transportability is essential. It may be recharged from the mains using Battery Charger ZG 0113 (supplied), or recharged and operated from the mains using the optional Mains Power Supply ZG 0199.

Fig. 4. Control panel of Type 4912, showing Rubber Sheath DS 0594 fitted for protection

Specifications 4912

FREQUENCY RANGES:
Flash Rate: 0 to 130 Hz (with external triggering)
Internal Generator: 5 to 125 Hz
Display: 0 Hz to 1500 Hz and 0 r/min to 90000 r/min. Display flashes if upper limit is exceeded
External Trigger: 0 to 20000 Hz

TACHOMETER DISPLAY:
Type: 4-digit liquid crystal display, 7-segment numerals 12 mm (0,5 in) high
Configuration: Display reads Hz to nearest 0,1 or 1 Hz, and r/min to nearest 1 or 10 r/min
Accuracy: ± 1 part per thousand,
± 0,1 Hz or ± 1 r/min in lower ranges
± 1 Hz or ± 10 r/min in higher ranges

LIGHT SOURCE:
Type: Xenon white-light discharge tube
Average Light Output: Greater than 2500 lux up to 250 mm (10 in) range and greater than 1000 lux up to 500 mm (20 in) range, for flash rates above 25 Hz (1500 r/min)
Flash Duration: 5 μs approx.
Lamp Life: 200 hours at flash frequencies above 25 Hz; longer for lower frequencies
Beam Diameter: Typically 60 mm (2,4 in) at 500 mm range

EXTERNAL TRIGGER:
Connector Type: 3-pole coaxial BNC, accepting plug JP 0315
Trigger Sensitivity: 200 mV Pk-Pk
Trigger Level: Adjustable from + 400 mV to − 400 mV
Supply for Trigger Source: + 5 V DC to + 7 V DC (internal batteries), or + 6 V DC to + 10 V DC (ext. power source), on pole no.2 (ring) of socket, referred to shield (can be used to power photoelectric Probe MM 0012 or MM 0024)

POWER INPUT:
Connector Type: standard 7-pin DIN socket accepting plug JP 0703
Charging: + 6 to + 15 V DC, 0 to 600 mA, 7 hours at max. rate; or from battery charger ZG 0113, 10 hours
External Power: + 6 to + 15 V DC, max. 7 W to 15 W respectively with stroboscope operation, 1 W to 5,5 W respectively with tacho. only
Battery Condition: moving-coil indicator

ELECTROMAGNETIC COMPATABILITY:
Complies with Class B computing device of American FCC (Federal Communication Commission) Rules

TEMPERATURE RANGE:
− 10° to + 50°C (14° to 122°F);
display only, 0° to 50°C (32° to 122°F)

WEIGHT:
1,3 kg (2,8 lb approx.)

DIMENSIONS:
Height: 265 mm (10,4 in)
Width: 135 mm (5,3 in)
Depth: 93 mm (3,7 in)

ACCESSORIES INCLUDED:

Battery Charger	ZG 0113
3-pole BNT plug	JP 0315
7-pin DIN plug	JP 0703
2 spare fuses	VF 0010
Tripod Bush Adaptor	DB 2164
Rubber Sheath	DS 0594

ACCESSORIES AVAILABLE:

Photoelectric Probe	MM 0024
Photoelectric Probe	MM 0012
Magnetic Probe	MM 0002
Mains Power Supply	ZG 0199
Control Cable for ZG 0199	AQ 0035
Tripod Bush Adaptor	UA 0588
Lamp	VS 1004

2. CONTROLS

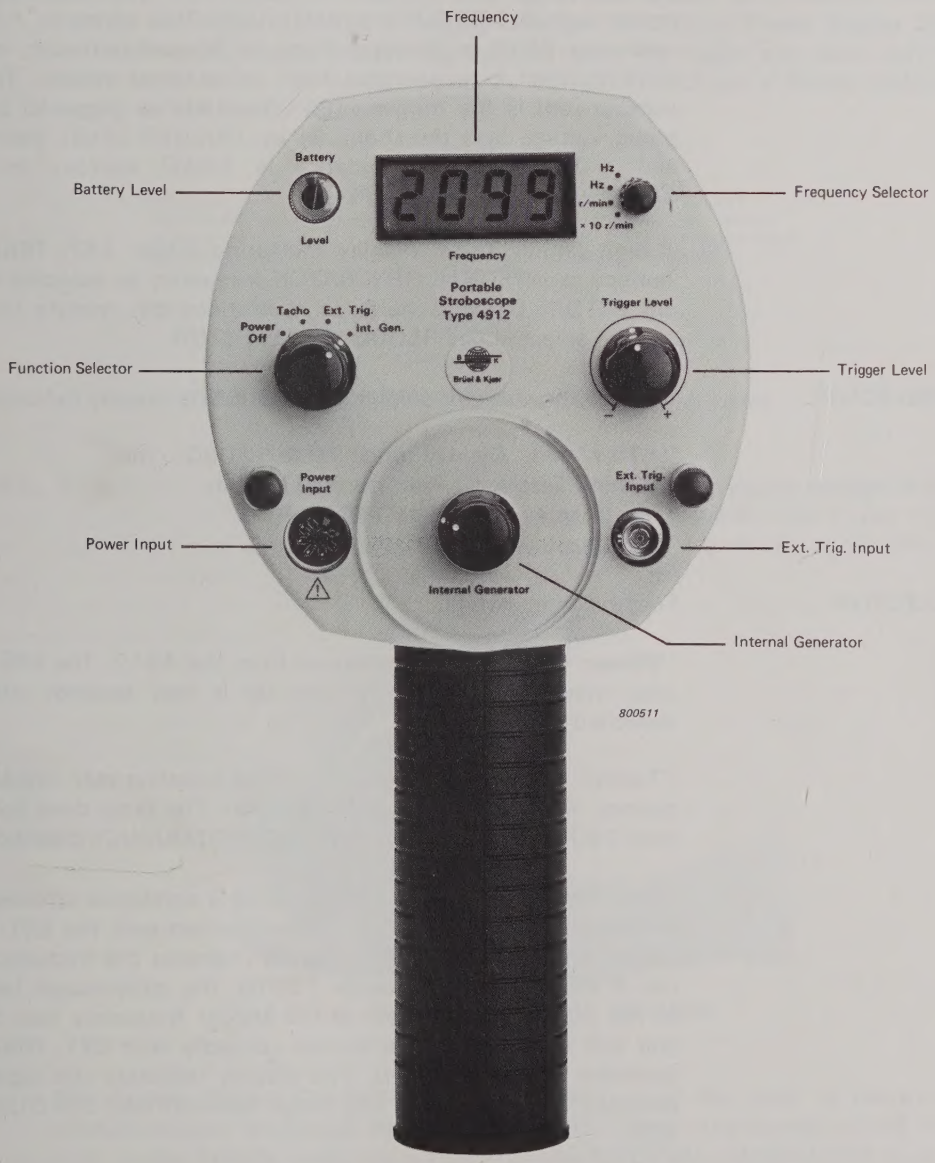


Fig.2.1. Rear panel of the 4912

BATTERY LEVEL:

Moving-coil indicator of the battery condition. Also indicates whether voltage is sufficient when external power is used. The pointer leans to the left when the instrument is switched off or the battery or external voltage insufficient to power the 4912 within specification. The pointer leans to the right when the voltage is sufficient. If the indicator

shows that the battery voltage is insufficient, the battery should be recharged (section 3.2.1).

EXT. TRIG. INPUT

Three-pole coaxial socket accepting standard BNT plug JP 0315 (supplied) or standard BNC plug JP 0035 to trigger the stroboscope lamp externally or feed the tachometer. The sheath (outermost contact) is ground, and is connected to pin 2 of POWER INPUT. The middle contact (ring) carries a positive DC supply for an active tachometer probe such as MM 0012 or MM 0024. This supply is + 5 V to + 7 V when the 4912 is powered from its internal batteries, and + 6 V to + 15 V when it is powered from an external source. The innermost contact (tip) is the trigger input. The 4912 is triggered by a positive-going voltage at a threshold set by TRIGGER LEVEL between −0,4 V and + 0,4 V. Input impedance is 50 kΩ approx., in series with 680 nF. Max. input 30 V Pk–Pk.

FREQUENCY:

4-digit liquid crystal display indicating either EXT. TRIG. INPUT frequency or INTERNAL GENERATOR frequency as selected by FUNCTION SELECTOR. Displays hertz or revolutions per minute (r/min) in four ranges selected by FREQUENCY SELECTOR.

FREQUENCY SELECTOR:

4-position switch for selecting FREQUENCY display indication.

"× **10 r/min**" Display range 10 to 90000 r/min.
"**r/min**" Display range 1 to 9000 r/min.
"**Hz**" Display range 1 to 1500 Hz.
"**Hz**" Display range 0,1 to 150,0 Hz.

FUNCTION SELECTOR:

Four-position switch.

"**Power Off**" Power is removed from the 4912. The FREQUENCY display may continue to indicate for a few seconds after power is switched off.

"**Tacho**" The 4912 behaves solely as a tachometer, displaying the frequency of the EXT. TRIG. INPUT signal. The lamp does not light. Upper limit 1500 Hz (signified by flashing of FREQUENCY display).

"**Ext. Trigger**" The 4912 behaves as a combined stroboscope and tachometer. The lamp flashes in synchronism with the EXT. TRIG. INPUT signal, and the FREQUENCY display indicates the frequency of this signal. If this frequency exceeds 130 Hz, the stroboscope lamp will flash at the highest submultiple of the trigger frequency less than 130 Hz, and will continue to synchronize correctly with EXT. TRIG. INPUT frequencies up to 20000 Hz. The display indicates the signal frequency provided this lies within the range selected with FREQUENCY SELECTOR.

"**Int. Gen.**" The 4912 behaves as a free-running stroboscope. The stroboscope lamp flashes at the frequency set by INTERNAL GENERATOR and indicated on the FREQUENCY display in Hz or r/min as selected. The frequency range available is 5 to 125 Hz.

INTERNAL GENERATOR:

10-turn thumb-wheel for setting the frequency of the internal generator between 5 Hz (maximum anticlockwise) and 125 Hz (maximum clockwise). Operative only in "**Int. Gen.**" position of FUNCTION SELECTOR.

POWER INPUT:

Standard 7-pin DIN socket accepting plug JP 0703, for recharging the battery and/or powering the instrument from an external source. The connections are shown in Fig.2.2. Pin 2 is connected to the outermost contact of EXT. TRIG. INPUT. When a plug is inserted, the 4912 can be powered only from an external source, unless the plug has been modified as described in section 3.2.

⚠ **Warning:** For reasons of safety, this apparatus should be powered only from (*a*) its internal batteries, (*b*) a B & K Battery Charger ZG 0113 or Power Supply ZG 0199, or (*c*) an external DC supply electrically isolated from the mains and used only for powering instruments within the same set-up as the 4912, such as a *Safety Extra-Low Voltage* supply as defined by IEC 348.

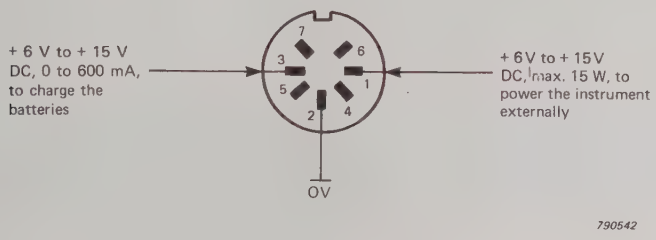


Fig.2.2. POWER INPUT connections (external view)

TRIGGER LEVEL:

Single-turn level-setting control for adjusting the voltage at which the EXT. TRIG. INPUT operates. Adjustable between −0,4 V and +0,4 V. Trigger sensitivity 0,2 V Pk–Pk, rising to 0,4 V Pk–Pk at 20 kHz.

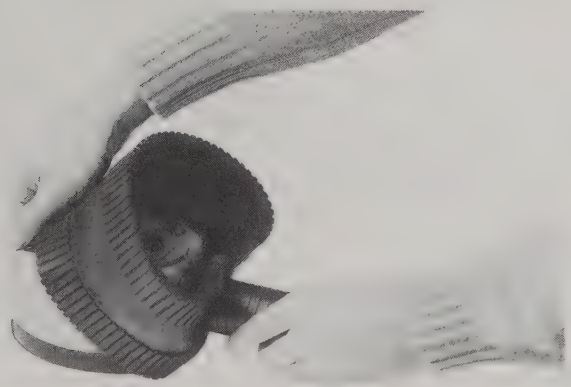


Fig.2.3. Installing Rubber Sheath DS 0594

The Rubber Sheath DS 0594 should be fitted round the body of the Stroboscope, to protect it from accidental damage. To do this, insert the handle of the 4912 into the hole in the Sheath, with the cut-out for the INTERNAL GENERATOR knob towards the rear. Push the Sheath right up the handle as far as it will go (Fig.2.3). With the Stroboscope lying face down on a table, use both hands to ease the Sheath over the body of the Stroboscope till it is a snug fit. Avoid applying *excessive* force to the handle.

3. OPERATION

3.1. ENVIRONMENT AND MOUNTING

The Portable Stroboscope Type 4912 may be used over a wide temperature range, –10° to +55° (14° to 131°F). The permissible upper limit of relative humidity is 90%, non-condensing measured at 30°C.

The carrying handle of the 4912 incorporates a standard tapped hole for tripod mounting (3/8-in Whitworth). It may be mounted on the portable tripod UA 0587 or any other similar support. It may also be stood upright on its base provided the supporting surface is reasonably level.

3.2. POWER SOURCES

The Type 4912 may be powered from its internal rechargeable batteries, or from a suitable external source. The pointer of the BATTERY LEVEL indicator leans to the right (thus: /) when the battery voltage is sufficient to power the 4912. This condition will occur after a relatively short period of charging. Consequently the indicator cannot be used as a guide to whether or not the battery is fully charged. The only way to be sure that the battery is fully charged is to keep the 4912 on charge for the period of time specified below. The indicator will show whether or not the battery has received some charge; it will also show eventually whether the battery needs to be replaced by indicating that the battery voltage falls to below the usable level after a shorter operating time than when the Stroboscope was new. The battery can undergo approximately a thousand charge/discharge cycles before its performance deteriorates, however. Replacement is a service operation. Note that the true battery condition is indicated by the BATTERY LEVEL indicator only when the charging source is switched off or disconnected.

For details of how to replace the lamp or fuse, refer to the separate *Service* manual supplied.

3.2.1. Battery Charger ZG 0113

The simplest method of recharging the batteries is to use the battery charger ZG 0113 supplied (Fig.4, Chapter 1). Before this can be done, the battery charger must be fitted with a suitable plug for connection to a single-phase AC mains supply. For mains voltages between 100 V and 130 V, connect the supply between the blue and black conductors in the unterminated cable attached to the battery charger. For voltages between 200 V and 240 V, connect it between the blue and brown conductors. The unused conductor should be cut back or insulated.The 7-pin DIN plug attached to the other cable on the battery charger is then plugged into the POWER INPUT socket on the 4912. Recharging completely exhausted batteries takes about 10 hours with the ZG 0113. No harm will result from prolonging the charging time. However, if the instrument is used infrequently, it should not be left on permanent charge as this practice tends to shorten battery life.

3.2.2. Operation while Charging

The 4912 cannot be operated while connected to the battery charger unless the 7-pin DIN plug is modified as follows. Slide back the plastic sheath round the plug and remove the two parts of the metal screen. To free the sheath it may be necessary to depress the metal key visible through a window in the side of the sheath. The 4912 may then be operated whether or not the modified plug is pushed into the POWER INPUT socket for recharging, provided the batteries are not completely exhausted to begin with. When the Stroboscope is operating at more than about 20 flashes per second, it drains more current from the battery than can be supplied from the ZG 0113 (which is intended only for charging, not for powering). However, the use of the ZG 0113 during operating can greatly extend the operating-time of the 4912 between charges.

3.2.3. Accelerated Charging

The rapid-charge batteries of the 4912 may be completely recharged from exhaustion in 7 hours if a charging source of 600 mA is provided. The required voltage at this current is 15 V. Neither figure should be exceeded. The charge source positive should be connected to pin 3, and negative to pin 2, at the POWER INPUT connector (see Fig.2.2).

3.2.4. External Power

The 4912 may be powered from a 6 to 15 V supply connected to POWER INPUT with positive to pin 1 and negative to pin 2, whether or not the batteries are being charged at the same time. The maximum power consumption varies from 1 W at 6 V DC to 5,5 W at 15 V DC with tacho-only operation, and from 7 W at 6 V DC to 15 W at 15 V DC with stroboscope operation. The 4912 is protected against accidental reverse connection of the external power source.

Mains Power Supply ZG 0199, available separately, may be used to operate the 4912 while at the same time recharging the batteries from exhaustion in abou 10 hours to full charge. To do this, connected the ZG 0199 to a suitable mains supply as described in its Instruction Manual, connect its OUTPUT socket to POWER INPUT on the 4912 using cable AQ 0035 and set the OUTPUT SELECTOR switch to "Drive Voltage On—Charge On".

⚠ **Warning:** Avoid connecting the 4912 to an external power source whose *positive* conductor is connected to earth, signal ground or any exposed metalwork. This arrangement could result in destructive short-circuit currents, since the negative terminal (pin 2, 0 V) of the POWER INPUT socket on the 4912 is connected to its case, and to the signal ground of any other instruments which may be connected via the EXT. TRIG. INPUT.

3.3. FREE-RUNNING STROBOSCOPE OPERATION

The Stroboscope lamp will begin flashing at a rate determined by the setting of INTERNAL GENERATOR as soon as FUNCTION SELECTOR is set to "Int. Gen.", unless BATTERY LEVEL indicates that there is insufficient supply voltage for proper operation. The pointer leans to the right when the voltage is sufficient. If it does not, recharge the batteries or provide a suitable external power source as described in section 3.2.

To obtain a stationary or slowly moving image of a rapidly moving object, first ensure that the object is illuminated mainly by light from the Stroboscope. Fig.3.1 and Table 3.1 show the characteristics of the beam from the lamp. Set INTERNAL GENERATOR to its maximum clockwise position, and then turn it gradually anticlockwise while observing the object. When the knob is at certain positions, you will see multiple stationary images of the object (unless

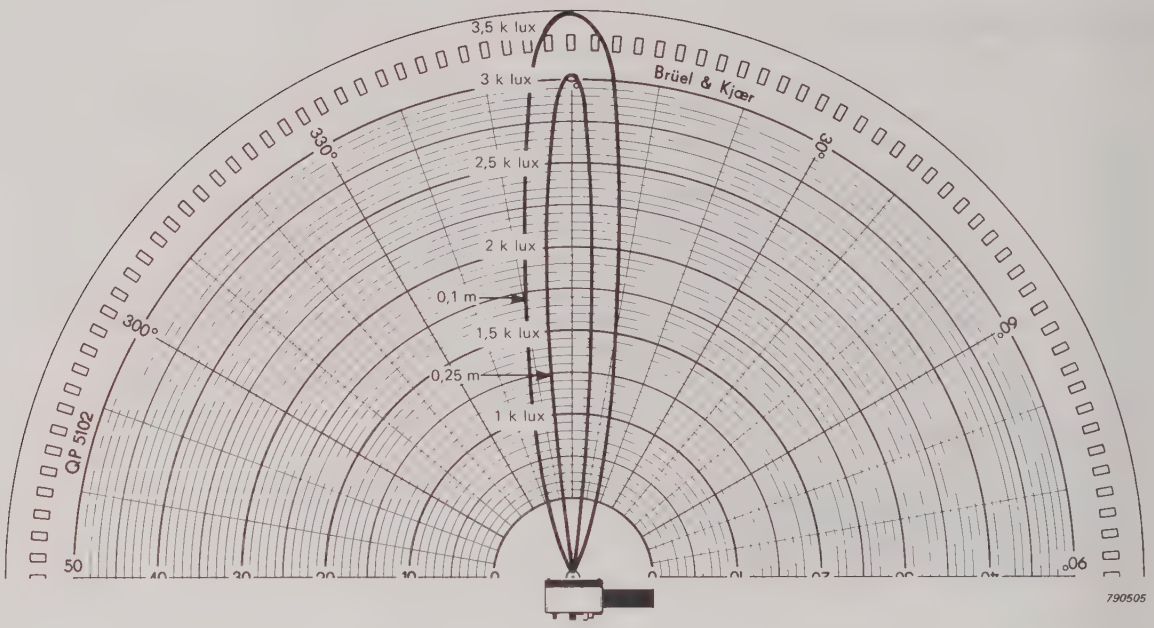


Fig.3.1. Polar diagram showing typical beam geometry for the 4912 light source

Amount off axis	Illuminance (lux) Distance from lamp (m) 0,1	0,25	0,5	1,0
0°	3400	3000	1000	330
1°		2950	980	300
2°	3300	2800	900	220
3°		2300	700	150
4°		2000	450	100
5°	3000	1500	300	70
6°		1000	200	45
7°	2400	500	100	31
10°	1500	170	30	8
15°	800			
20°	250			
25°	150			
30°	100			

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Table 3.1. Typical beam geometry characteristics for the 4912 light source

the frequency of motion is very high), because at each of these positions the flash rate of the Stroboscope corresponds to a particular harmonic of the motion frequency of the object. Stop turning the knob anticlockwise at the *first position* for which a *non-multiple* stationary image is obtained. This will happen when the flash rate and the motion frequency are identical; they may be read off the FREQUENCY indicator. To obtain the desired form of indication (Hz or r/min), set FREQUENCY SELECTOR as preferred.

Sometimes it can be difficult to distinguish multiple and single images of a rotating object which is rotationally symmetrical, such as a fan or gear wheel. In such cases it is helpful to stop the machine and make a distinctive mark, with chalk or ink, on the rotat-

ing part. Start the machine again and obtain a stationary imagine. Check that the mark occurs at only one point in its orbit, and if it occurs at several, reduce the Stroboscope frequency. If exclusion of ambient light proves to be difficult, the contrast of such a mark can be improved by the use of a patch of retroreflective adhesive tape. This material has the property of reflecting light back along its incident direction. A patch of this tape stuck to the rotor should be viewed from a position immediately adjacent to the Stroboscope in order to maximise the strobed patch brightness. Light falling on the patch from other directions will not be reflected into the eye.

The large diameter of the INTERNAL GENERATOR wheel enables the 4912 to be operated with one hand, when it is used in this mode. The wheel may be set with the thumb of the hand holding the handle.

The direction of rotation or linear motion of objects may be determined by offsetting the INTERNAL GENERATOR frequency slightly from a position of synchronism. If the wheel is off-set anticlockwise (lower flash rate), the direction of apparent motion is the same as the direction of actual motion.

The frequency range of the internal generator is 5 to 125 Hz (flashes per second), corresponding to 300 to 7500 revolutions per minute. Objects having higher motion frequencies may be observed readily; more than one cycle of motion will then take place between flashes.

If the highest stationary single image is obtained with a flash frequency of more than 62,5 Hz (3750 r/min), it is possible that the motion frequency is higher than this. It could be two, three or more times the flash frequency. To find out whether this is so, and if it is, determine the true motion frequency, proceed as follows:

1. Record the highest flash frequency (in Hz) at which a single stationary image is obtained.

2. Continue turning the INTERNAL GENERATOR wheel anti-clockwise, reducing the frequency until another single stationary image is obtained. If this occurs when the flash frequency has fallen to *half* the frequency recorded in step 1, then the true motion frequency is the same as the flash frequency recorded in step 1.

3. If the next single stationary image is obtained at a frequency greater than *half* the frequency recorded in step 1, record the flash frequency (in Hz) at which it occurs.

4. Locate the highest flash frequency (from step 1) on the left-hand scale in Fig.3.2.

5. Locate the second-highest flash frequency (from step 3) on the centre scale in Fig.3.2.

6. Lay a straight edge across Fig.3.2 so that it passes through the two points located in steps 4 and 5.

7. The true motion frequency may be read off the right-hand scale, in Hz or r/min, at the point where the straight edge intercepts the scale.

Example

Highest flash frequency = 75 Hz (left-hand scale)
Second-highest frequency = 50 Hz (centre scale)
Follow broken line to right-hand scale
True motion frequency = 150 Hz = 9000 r/min.

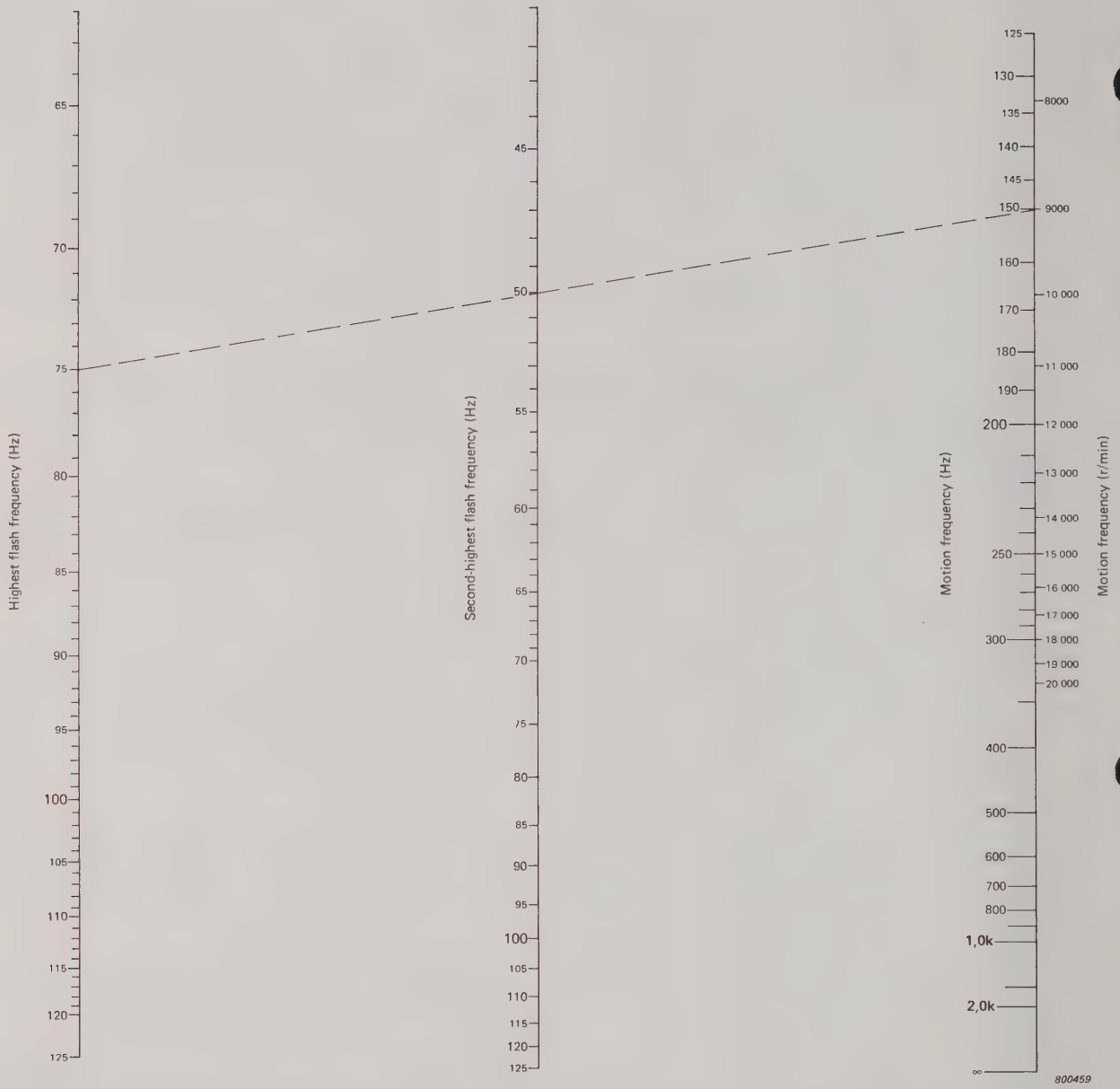


Fig.3.2. Nomogram for determining motion frequencies higher than 125 Hz with free-running stroboscope operation

Fig.3.2 is obtained from the equation:

$$\frac{1}{f_m} = \frac{1}{f_{h-1}} - \frac{1}{f_h}, \qquad \textit{i.e.,} \qquad f_m = \frac{f_{h-1} f_h}{f_h - f_{h-1}},$$

where:

f_m = true motion frequency;
f_{h-1} = second-highest flash frequency;
f_h = highest flash frequency.

When FUNCTION SELECTOR is set to "Power Off", the indication on the FREQUENCY DISPLAY may linger for a few seconds. This is a normal condition.

3.4. OPERATION FROM AN EXTERNAL TRIGGER

In both the "Tacho" and "Ext. Trig." settings of FUNCTION SELECTOR, the 4912 will operate only if a suitable changing voltage is applied to the EXT. TRIG. INPUT, as described below.

In the "Tacho" setting, the Stroboscope lamp does not flash at all — this position enables the 4912 to function solely as a tachometer, indicating the frequency of the EXT. TRIG. INPUT voltage on its FREQUENCY display, in a form selected by means of FREQUENCY SELECTOR. The indication limits are 5 to 1500 Hz (corresponding to 300 to 90000 revolutions per minute). If the external trigger frequency exceeds the upper limit, the FREQUENCY display will flash to indicate overload. The 4912 will operate for approximately 15 hours from the internal batteries between charges in the "Tacho" mode.

In the "Ext. Trig." setting of FUNCTION SELECTOR, the lamp is triggered by the voltage at EXT. TRIG. INPUT, and although the maximum flash rate is limited to 130 flashes per second, the flashes can be synchronized with trigger frequencies up to 20000 Hz. The FREQUENCY display indicates the trigger frequency. In this mode the lamp can also be triggered by events occurring at irregular or sequentially varying intervals.

The 4912 is triggered externally by a rising voltage passing a threshold set between −0,4 V and + 0,4 V by means of TRIGGER LEVEL, which should be adjusted as necessary to obtain satisfactory triggering.

Specific considerations concerning external triggering by other instruments and photoelectric and magnetic probes are dealt with in the following sections.

3.4.1. Triggering from another Instrument

The 4912 may be triggered from the AC recorder output from a measuring instrument such as the B & K Portable Vibration Meter Type 2511, for use in dynamic balancing, for example. It may be triggered from an excitation source such as the output of a sine generator or exciter control (B & K Types 1023, 1027 or 1047 for example) for loudspeaker analysis or mode study vibration testing. For these applications the appropriate output from the instrument should be connected to EXT. TRIG. INPUT on the 4912 by means of a standard BNC plug (JP 0035). Various ready-wired cables are available from B & K.

The EXT. TRIG. INPUT on the 4912 has an input impedance of 50 kΩ and is AC-coupled by a 0,68 μF capacitor. The alternating component of the voltage applied to it should not exceed 30 V Pk–Pk. The DC component should be kept within ± 63 V. The trigger level may be adjusted as required between −0,4 V and + 0,4 V as described above.

3.4.2. Triggering from Photoelectric Probe MM 0012

The Photoelectric Tachometer Probe MM 0012 (Fig.1, Chapter 1) provides a very convenient transducer for triggering the 4912 where the range of motion is great enough, i.e., more than a few millimetres. The MM 0012 is supplied complete with a 3 m connecting cable AO 0158 which should be used to connect it to EXT. TRIG. INPUT on the 4912. This cable also carries the supply to the MM 0012, which is an active device.

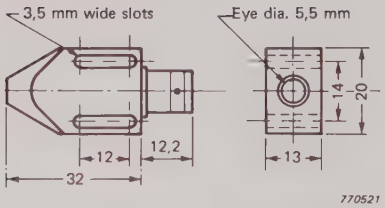


Fig.3.3. Dimensions of Photoelectric Tachometer Probe MM 0012

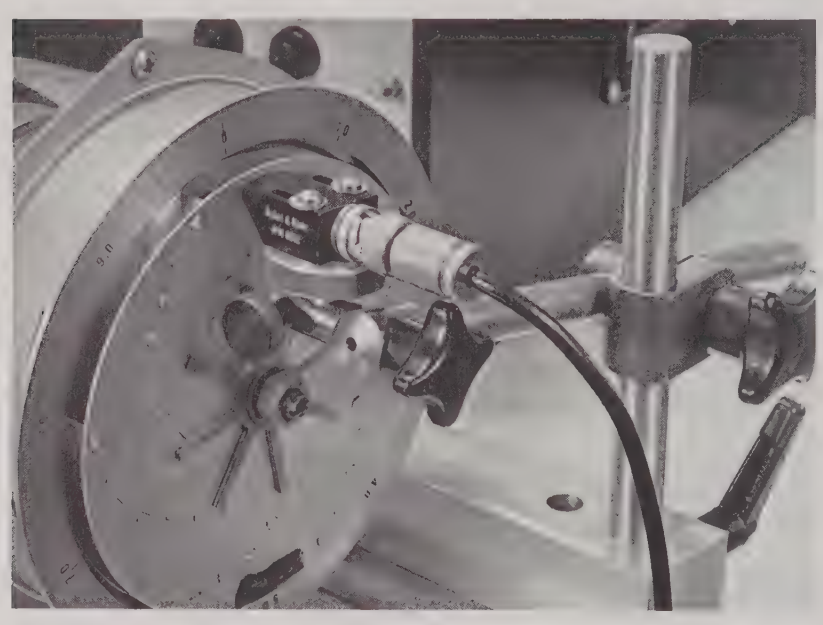


Fig.3.4. MM 0012 Photoelectric Tachometer Probe in use

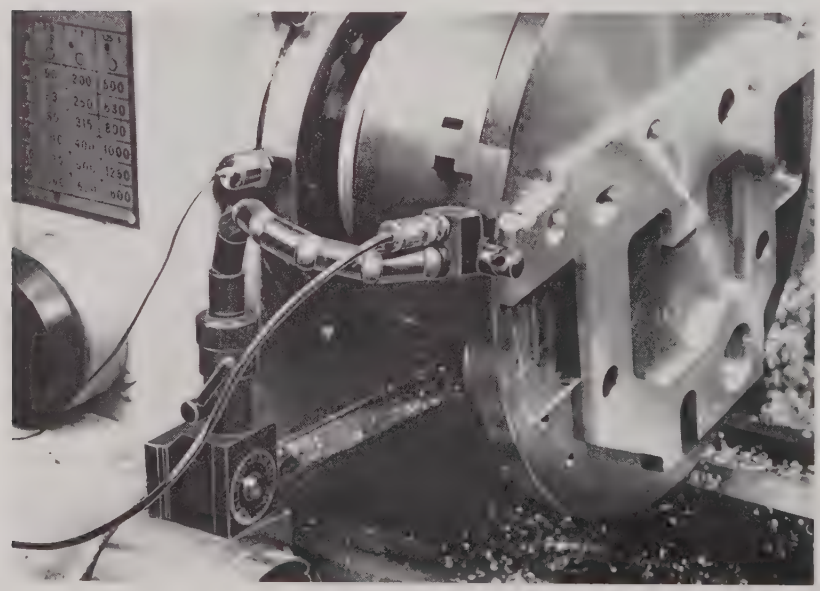


Fig.3.5. MM 0012 Photoelectric Tachometer Probe in use

Detailed information on how to apply the Probe is given in the Product Data sheet describing the MM 0012. It should be fixed at a distance of about 1 mm from the moving surface for best results, though it can be used at a greater distance, especially if it is assisted by an auxiliary light source such as a hand torch powered by a battery (not mains). The surface should have fixed to it a contrasting mark (light on dark, dark on light) whose passage through the beam causes triggering. The lamp will flash in synchronism with the dark-to-light transition. The dimensions of the MM 0012 are shown in Fig.3.3, and examples of fixing arrangements in Figs.3.4 and 3.5.

3.4.3. Triggering from Photoelectric Tachometer Probe MM 0024

Using the Photoelectric Tachometer probe MM 0024 (Fig.2, chapter 1) for triggering has the advantage that it may be located any distance between 50 and 800 mm from the subject to be investigated, thus safely separating the probe from possible contact with moving parts. The MM 0024 is supplied with a 3 m connecting cable AO 0158 which should be used to connect it to EXT. TRIG. INPUT on the 4912. This cable also carries the supply to the MM 0024. Use of the Probe is very straightforward. It is mounted on a convenient static part of the machine using a magnetic clamp, or a suitable bracket.

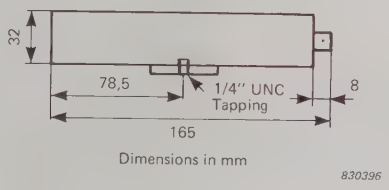
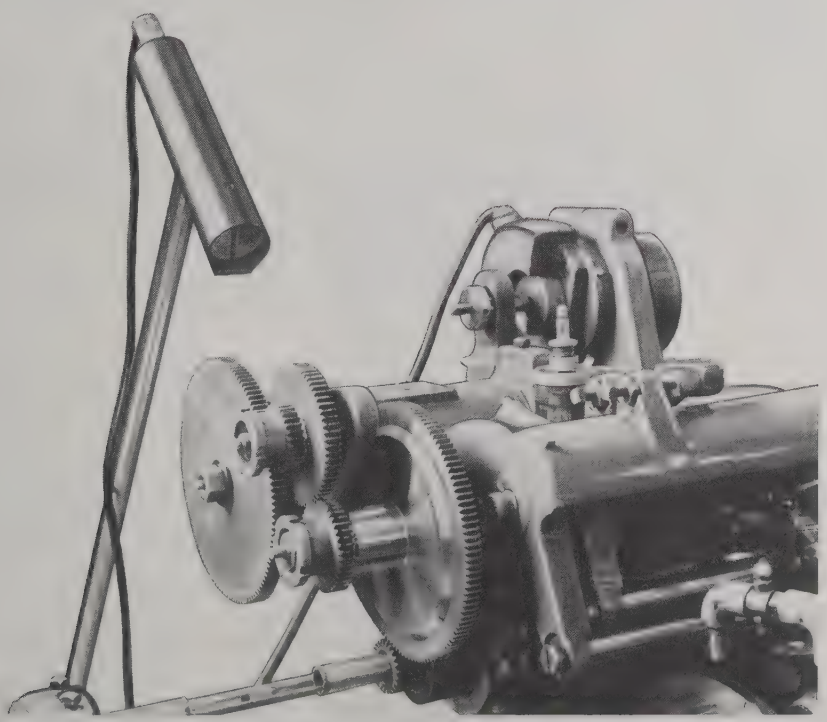


Fig. 3.6. Dimensions of Photoelectric Tachometer Probe MM 0024



Alternatively, a camera tripod with standard 1/4″ UNC (DIN 4503) thread can be employed instead. The Probe should be directed such that its infra-red window faces the subject on which a small strip of self-adhesive reflective tape (QA 0137) has been previously attached. This has the property of reflecting the infra-red beam back to the receiver during each cycle of the moving part, resulting in a positive electrical pulse output from the receiver to the measurement instrumentation.

A small LED (Light Emitting Diode) flashes on the Probe body when reflected light pulses are received, giving the user a positive indication of correct orientation relative to the moving object.

The dimensions of the MM 0024 are shown in Fig.3.6, and an example showing it mounted is given in Fig.3.7.

3.4.4. Triggering from Magnetic Transducer MM 0002

The Magnetic Transducer MM 0002 (Fig.3, Chapter 1) is a variable-reluctance device with a built-in permanent magnet. Changes in the reluctance of its magnetic circuit, part of which is external to the Transducer, cause a voltage at its terminals. This voltage can be made sufficient to trigger the 4912.

If the moving object to be studied with the Stroboscope is ferromagnetic, it is sufficient to mount the Transducer so that the object passes as closely as possible — 1 or 2 millimeters — to the Transducer at its active end. The dimensions of the MM 0002 are given in Fig.3.8. If the moving object is not ferromagnetic, or the motion is continuous rather than reciprocating, one of the high-μ discs supplied with the Transducer may be cemented to the moving object or secured with a double-sided self-adhesive disc YO 0073. The Transducer is supplied with a 1,2 m connecting cable AO 0038, requiring adaptor JP 0145 (not supplied) to connect the 10-32 UNF miniature screw-locking coaxial plug on the cable to the EXT. TRIG. INPUT socket on the 4912.

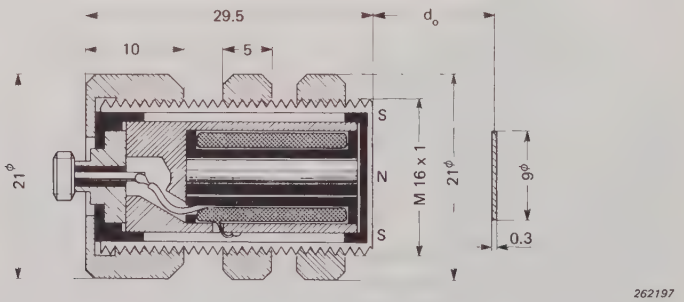


Fig. 3.8. Dimensions of Magnetic Transducer MM 0002

The Magnetic Transducer is especially to be preferred for triggering in dirty environments or in general where the optical technique of the MM 0012 or MM 0024 is not suitable. For more detailed information, refer to the Product Data for the MM 0002.

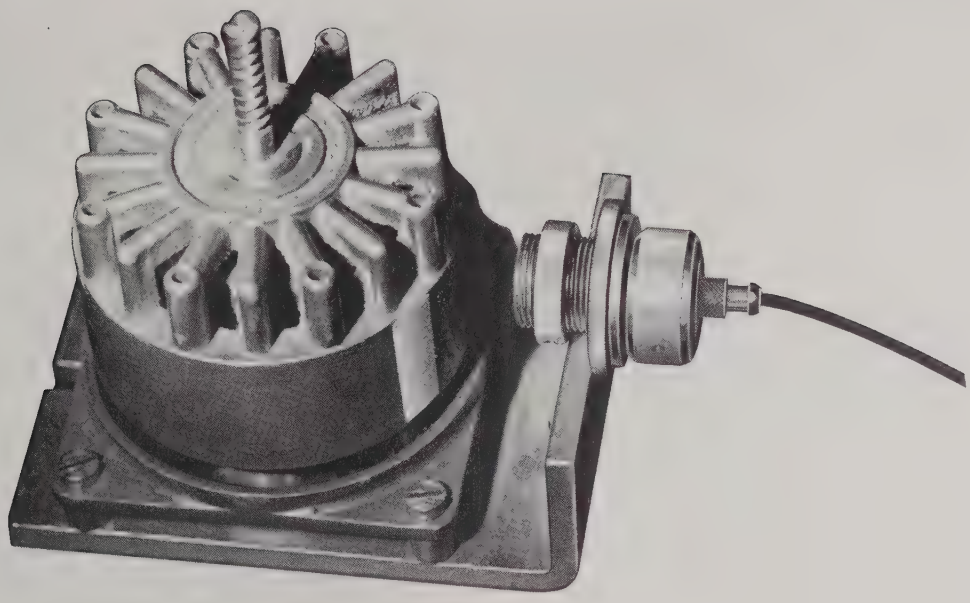


Fig. 3.9. MM 0002 Magnetic Transducer in use

3.4.5. Single-Flash Triggering

A single flash can be obtained when FUNCTION SELECTOR is set to "Ext. Trigger" by connecting together the tip and the ring of the EXT. TRIG. INPUT socket, momentarily. TRIGGER LEVEL should be set with the white mark on the knob slightly to the left of the central position. This facility may be used to trigger the flash from the flash contacts of a camera.

For correct synchronization of the shutter, the "X" contacts should be used on the camera. Select the shutter speed in accordance with the recommendations in the camera's instruction manual for its use with electronic flash. In general, any shutter speed may be used with a between-the-lens shutter. With a camera having a focal-plane shutter, the highest speed which may be used is usually limited to some setting between 1/30 and 1/125 s, depending on the characteristics of the shutter. This setting will be stated in the instruction manual. If in doubt, use a setting of 1/30 s or longer.

Photography with the 4912 is discussed in section 3.5.

3.5. PHOTOGRAPHY WITH THE 4912

The recommended exposures for photographing objects illuminated by the flash of the 4912 are given in Table 3.2. The conditions in which they will be found optimum are: subject-to-lamp distance, 250 mm (10 in); subject elements illuminated, up to 2,5° off axis.

The 4912 may be set to give a single flash in synchronism with the opening of the camera shutter, as explained in section 3.4.5. In this case the exposures given in the first column of the Table should be used.

If the camera is not synchronized with the 4912, then a shutter speed must be selected which is slow enough to ensure that at least one flash occurs while the shutter is open. It is preferable to ensure that at least three occur, to minimize the effect of the uncer-

tainty of the timing on the actual number of flashes which do occur. If the flash frequency F is less than 25 Hz, then the number of flashes which occur during shutter-open time should be calculated, and the exposure read from the corresponding column of the Table. F should be read from the FREQUENCY display provided this indicates less than 25 Hz (1500 r/min). Set FREQUENCY SELECTOR to one of the "Hz" positions. The number of flashes which occur can be calculated from the formula F × T, where T is the exposure-time in seconds.

If the flash rate F exceeds 25 Hz (1500 r/min), then the exposure received by the film will be independent of F, provided at least three flashes occur while the shutter is open. This is because the *averaged* illuminance generated by the 4912 is kept constant above 25 Hz. In this situation the exposure should be taken from the column corresponding to the actual shutter speed setting in use. It is preferable that F is greater than or equal to 3 × 1/T.

The recommendations made in Table 3.2 are for black and white film. Reliance should not be placed on their application to colour film. Instead, the user should experiment with several exposures to determine the most suitable. Acceptable pictures on colour films having the same speed ratings as the black and white films given may be obtained from the use of the table, or an increase in exposure may be found necessary.

Number of flashes occuring while the shutter is open: (Flash rate less than 25 Hz)	1	2	4	8
Exposure-time in seconds: (Flash rate greater than 25 Hz)	1/30	1/15	1/8	1/4
Aperture settings for Kodak Tri-X	f/4	f/5,6	f/8	f/11
Aperture settings for Kodak Plus-X	f/5,6	f/8	f/11	f/16

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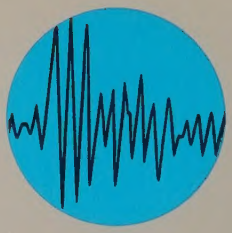
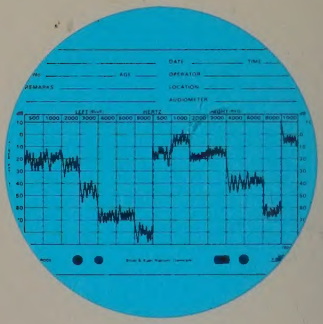
Table 3.2. Recommended exposures for photography with the 4912

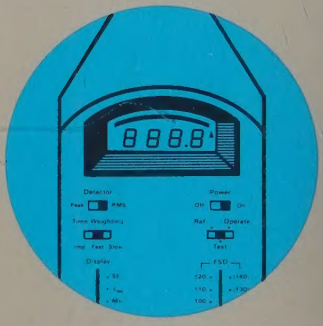
If the purpose of using the 4912 for photography is to obtain a clear picture of a moving object, it is important to ensure that the illumination of the object by the 4912 predominates over its illumination by other light sources. This can be checked in cases of uncertainty by measuring the exposure required in the absence of the 4912, using an ordinary photographic exposure meter. The measured exposure should significantly exceed that recommended in the Table, if an acceptable picture is to be obtained.

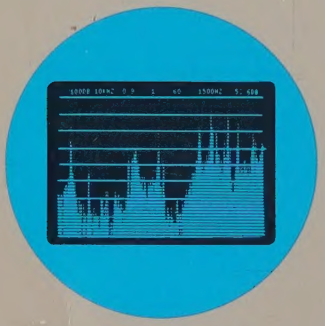
4. SERVICE AND REPAIR

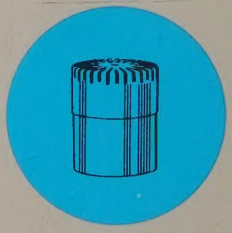
The 4912 is designed and constructed to provide the user with many years of reliable operation. However, should a fault occur which impairs its correct function, then all power should be disconnected to prevent the risk of further damage. For repair consult the separate Service Instruction provided or consult your local B & K service representative. Under no circumstances should repair be attempted by persons not qualified in the service of electronic instrumentation.

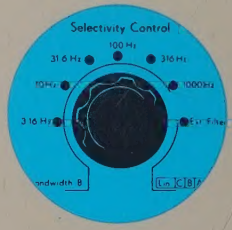


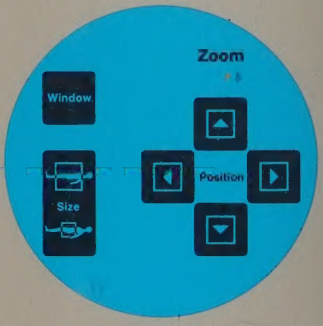


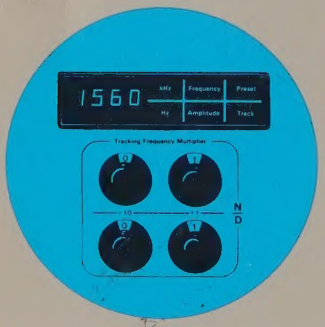


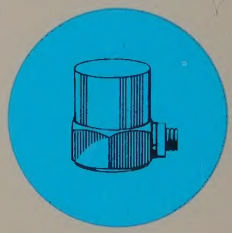


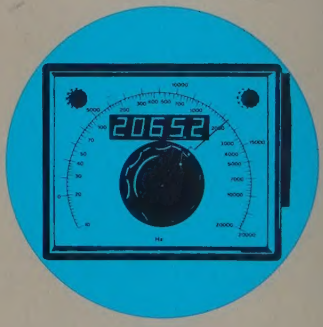


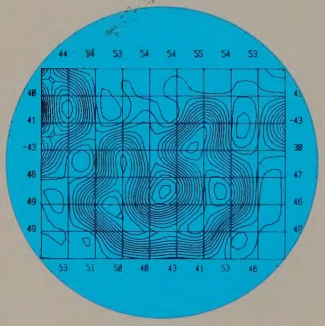


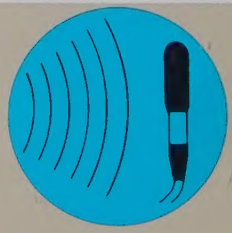


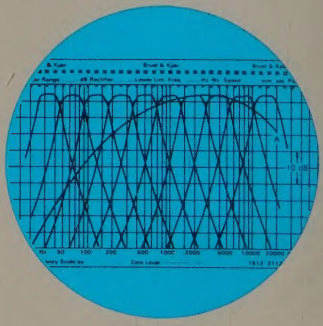












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